REFERENCE ONLY
THIS BOOK MAY NOT BE
TAKEN OUT OF THE LIBRARY

CODE OF GOOD AGRICULTURAL PRACTICE FOR THE PROTECTION OF SOIL

CONTENTS

1. INTRODUCTION

- about this Code
- laws on soil protection

2. SOIL FERTILITY

- biological activity
- acidification
- soil nutrient content
- organic matter

3. PHYSICAL DEGRADATION

- soil compaction
- topsoil removal
- soil erosion
- deep cultivation and mixing of soil
- loss of lowland peat

4. CONTAMINATION

- legal restrictions
- inorganic contaminants
- organic contaminants
- industrial contamination
- atmospheric deposition
- sewage sludge
- other industrial and domestic wastes
- animal manures
- inorganic fertilisers
- pesticides
- dredging materials
- remedial treatment
- sea water flooding
- oil spillage

5. RESTORATION OF DISTURBED SOILS

- legislation
- planning the work
- site working
- agricultural aftercare

6. APPENDICES

- Appendix 1. Maximum permissible concentrations of potentially toxic elements (PTEs) in soil after application of sewage sludge to agricultural land and maximum annual rates of addition.

LIBRARY

CODE OF GOOD AGRICULTURAL PRACTICE FOR THE PROTECTION OF SOIL

SECTION 1

INTRODUCTION

About this Code

(1) This Code of Good Agricultural Practice for the Protection of Soil is a practical guide to help farmers and growers avoid long-term damage to the soils which they farm. It also provides guidance to others whose activities may affect agricultural soils, on management practices which will maintain the ability of soil to support plant growth. It complements advice given in the Codes of Good Agricultural Practice for the Protection of Water (MAFF 1991) and of Air (MAFF 1992).

The Importance of Soil

Soil is a basic, limited resource that is and will remain the main support for human activities. As defined here, it includes both topsoil and subsoil to at least 1 m depth. The biological, physical and chemical characteristics of soils must be preserved in order that they can perform their important functions. These include production of food, raw materials and renewable energy. They also provide a link between potential pollutants, water and the food chain. They support natural and modified habitats and contain a critical genetic pool. Soils often cover historic and archaeological sites.

(2) In May 1972 the Council of Europe, of which the UK is a member, adopted the European Soil Charter. This emphasises that soil is a limited natural resource which is easily destroyed. It should be protected against damaging farming practices, erosion, pollution and damage from human settlement and civil engineering.

(3) This Code describes the main risks of causing irreversible or only slowly reversible physical, chemical or biological changes to soils which would reduce their ability to grow plants for commercial, conservation or recreational purposes and to support living organisms. In each section of the Code, Good Agricultural Practice is defined which aims to minimise the likelihood of such changes occurring. This Code is based on the best available information at the time of writing.

(4) The Code provides guidance on protecting the current condition of the soil. It does not include methods of soil improvement such as land drainage. It does not cover short-term effects that can reasonably be remedied in a year or two by natural processes and good management practices. The emphasis of the Code is to maintain soils

in a condition suitable for a wide range of current and future uses. It is recognised that particular plants and uses may need specific soil conditions that conflict with this general aim.

(5) The Code is mainly concerned with those topics on which preventative management action can be taken to protect the soil, including while it is temporarily not being used for growing plants. It also includes remedial actions to cope with contamination incidents such as sea flooding or oil spillage, and following soil disturbance such as mineral workings or laying pipelines.

(6) When applying the Code it is essential to recognise the properties of a particular soil and to apply appropriate measures. Failure to do so could make matters worse rather than better.

Laws on soil protection

(7) This Code is not a statutory code. Following it will not of itself protect you from legal action, although it should lessen the chance that this will happen. If you are in any doubt about what the law requires, you should seek professional advice.

Waste

(8) The disposal of industrial, household and commercial waste is regulated by measures laid down in the Control of Pollution Act 1974 (COPA), the Environmental Protection Act (EPA) 1990 (whose provisions are in the process of being implemented and will replace COPA), and the various regulations such as the Collection and Disposal of Waste Regulations 1988. Industrial, household and commercial wastes are defined under this legislation as "controlled wastes" and are subject to a number of provisions including licensing controls. Waste from premises used for agriculture is excluded from the definition of "controlled waste".

(9) Part I of the Environmental Protection Act 1990 establishes a new pollution control system called Integrated Pollution Control (IPC) for certain "prescribed processes" which is designed to reduce waste at source to a minimum. Anyone carrying out a prescribed process must apply for an authorisation. This is of particular relevance to industry. Industry must apply in advance to her Majesty's Inspectorate of Pollution (HMIP) for an authorisation to operate. IPC will enable HMIP to examine the potential impact of waste discharges to land, air and water and thereby assess the best practicable option for the environment as a whole and to minimise the effect of waste on the environment.

Special Waste

(10) Certain types of waste which are toxic or dangerous or difficult to treat, keep or dispose of are called "special waste" and are subject to very strict controls. For example, the Control of Pollution (Special Waste) Regulations 1980 regulate the disposal of waste that contains specified substances that make it dangerous to life or give it a flash point of 21° C or less. Medicinal products are also classified as special waste and their disposal is controlled. The Regulations prescribe a system of consignment notes which are to be used by those who produce, transfer for disposal, or dispose of, special waste. Local waste disposal authorities responsible for the supervision of the waste are notified in advance of its removal from place of production and disposers must record the location of the deposits of the special waste on their land.

Sewage Sludge

(11) About 50% of sewage sludge produced in the UK is now disposed of to agricultural land. Sewage sludge can contain heavy metals which, in excessive concentrations, can be toxic to humans, animals and plants. Sludge disposal to agricultural land is regulated throughout the EC by Council Directive 86/278 which is implemented in the UK by the Sludge (Use in Agriculture) Regulations 1989 as amended.

(12) The main requirements are:

- a prohibition of sewage sludge application to agricultural land when the concentrations of certain key heavy metals in the soil - lead, cadmium, mercury, copper, zinc and nickel - exceed specified limits;
- a restriction on the rate at which heavy metals in sewage sludge are added to soil;
- a prohibition for a minimum period of the grazing of animals on agricultural land following sludge application; and,
- a prohibition for a minimum period of ten months of the harvesting of fruit and crops which are normally eaten raw.

Additional safeguards are recommended in a complementary Code of Practice (DoE).

Contaminated Land

(13) Under Section 143 of the Environmental Protection Act 1990, local authorities are required to compile and maintain registers of land which is being, or has been, put to a use which may cause it to be contaminated. Contaminative use is defined as "any use of land which may cause it to be contaminated with noxious substances". Draft regulations have been issued for public consultation which specify contaminative uses of land, as well as the form of the registers and the particulars to be included in them. When the system of registers is fully in place, an inventory of land which may be contaminated by certain uses will be available to the public.

Minerals

(14) The extraction of minerals and disposal of mineral wastes is controlled under the Town and Country Planning Act 1990. Further provisions dealing with old mineral permissions which were in operation before the 1947 Town and Country Planning Act, are contained in the Planning and Compensation Act 1991.

Soil Stripping

(15) The stripping or removal of topsoil for sale is an offence under the Agricultural Land (Removal of Surface Soil) Act 1953, if planning permission is required but is not obtained. If soil is not required as part of a development project, it should be moved elsewhere for beneficial use.

Contamination of Radioactive Substances

(16) Radioactive waste discharges are controlled by the Radioactive Substances Act 1960. Under the 1960 Act, no such discharge may take place without prior Government authorisation.

SECTION 2

SOIL FERTILITY

(17) This section deals with chemical and biological aspects of fertility, including the acidification of soils, the maintenance of soil nutrient reserves and of organic matter content. Many effects are subject to short-term reversible change and can be dealt with as part of annual soil management. Only those aspects which take several years to change are covered. Loss of fertility due to physical degradation and chemical contamination are covered in subsequent sections of this Code.

Biological Activity

(18) Earthworms are one of the most obvious beneficial soil organisms. Along with other organisms, they are sensitive to certain chemicals which may be applied to the soil. These include some pesticides with a non-specific target range designed to control particular pests. Pesticides should always be carefully selected for the purpose required and used according to label instructions to minimise unwanted effects on non-target organisms.

(19) Fertilisers and manures containing a high proportion of nitrogen in the form of ammonium such as ammonium sulphate and pig slurry can suppress earthworm populations. In the case of slurry the longer-term effect may be to increase numbers due to the extra food source provided. Any detrimental effects of organic manures on earthworms may be reduced by avoiding slurry applications on wet, poorly drained soils or by applying composted materials such as well matured farmyard manure.

Acidification

(20) Acidification is a natural process which can occur in all soils but which can be increased by man's activities. The extent to which it happens depends on the character and composition of soils, acid deposition, cropping, nitrogen fertilisation and other management practices. Unless the soil is naturally well supplied with calcium or magnesium carbonate or is regularly limed, the effect is a reduction in soil pH until an equilibrium is reached. Soil at a low pH (<4) will support only a limited range of plant species and will not be suitable for agricultural production. Water that leaches from acid soils may contain chemicals which can adversely affect the quality of surface and groundwaters. In particular, populations of plants and animals living in streams and lakes may be harmed.

Definition of pH

pH is a way of expressing the acidity or alkalinity of a soil. pH 7 is neutral, lower values are said to be acid whilst alkaline soils are greater than 7. Most productive agricultural soils are maintained in the range pH 6.0-7.5 although 5.5 is adequate for grassland and some crops.

(21) The pH value of the cultivated layer of a soil can be maintained or raised by incorporation of liming materials which contain calcium or magnesium carbonate. The pH of non-cultivated soil or of the soil below the depth of cultivation can only be changed very slowly. For this reason it is important that uncultivated mineral soils and the mineral subsoils of cultivated soils are maintained at pH 5.0 or above unless the current and future use of the soil can be sustained at a lower value. This value is appropriate for growth of the widest range of both agricultural and other plant species. If the pH is below this, it can take many years to raise it to an appropriate level. Therefore where it is necessary, lime should always be worked into the soil before planting sensitive perennial crops such as fruit trees.

(22) Not all soils can be maintained at pH 5.0 or above particularly in the subsoil. Acid sulphate soils occur in limited areas of England and Wales, mainly in peat covered river valleys or marine alluvium. Acidification in these soils makes liming uneconomic and often fails to achieve a lasting increase in pH. These soils should generally be left in their natural state. Drainage of such soils permits oxidation of the naturally occurring sulphur compounds. This can adversely affect both the structure of the soil and the quality of the drainage water.

(23) Soils should not be overlimed. If too much lime is applied to a soil the availability of most plant nutrients will be decreased and plant growth reduced. It can take several years for excess lime to be removed from the soil.

(24) It is recognised that some soils are correctly maintained at a pH below 5.0 to grow and encourage particular species or plant communities. These soils will not be suitable for growing a wider range of species including most arable crops unless the pH is raised by liming.

(25) It is possible to reduce the pH of soil by applying acid forming materials such as flowers of sulphur. In practice, this is not suitable for large areas and the effect can be difficult to predict. If there is free lime, chalk or limestone in the soil it is not a practical option due to the large quantities of sulphur which would have to be applied.

Soil Nutrient Content

(26) To grow satisfactorily, plants need adequate supplies of the major nutrients nitrogen, phosphorus, potassium, magnesium, calcium, sulphur and sodium, and smaller quantities of the trace elements, iron, manganese, copper, zinc, molybdenum, boron and chlorine. These will generally be supplied by uptake from the soil, which may need to be supplemented by inorganic fertilisers and organic manures. Atmospheric deposition is also an important source of nutrients particularly of sulphur, nitrogen and some of the trace elements.

(27) As long as the soil pH and organic matter content are maintained at appropriate values, most of the additional nutrient requirements of plants can be met by annual applications of fertilisers or manures. If the soil is severely deficient, reserves can usually be raised in 2 or 3 years by generous use of fertilisers or manure. However care is needed to avoid water pollution by nitrogen, phosphorus or organic matter (see Code of Good Agricultural Practice for the Protection of Water). No more than 250 kg/ha of nitrogen in livestock wastes or other organic wastes should be applied in any one year.

(28) On inherently deficient clay soils it can be difficult to raise phosphorus reserves. In these situations fertiliser phosphorus can be tightly absorbed (fixed) and is not available to plants. It can take many applications of organic or inorganic fertilisers to satisfy the adsorption capacity so that the excess can raise the available soil phosphorus to a concentration suitable for general crop production. Once raised, the available soil phosphorus content should be maintained by appropriate regular applications of fertiliser.

(29) Particular plants or natural habitats such as flower-rich meadows may benefit from low soil nitrogen and phosphorus contents as this limits the growth of vigorous species such as rye grass which compete with the natural species. Such principles have been introduced into management regimes for some MAFF Environmentally Sensitive Areas.

(30) Excessive application of phosphorus in fertilisers or manures should be avoided. If soil particles with a high phosphorus content are eroded and deposited in rivers, lakes or the sea, the phosphorus content of the water will rise. This may cause eutrophication, often resulting in excessive growth of algae which uses up oxygen in water and can suffocate fish. Leaching of soluble phosphorus compounds can occur if a soil becomes near saturated with phosphorus.

(31) Excessive application of manures and nitrogen containing fertilisers can also contribute to water pollution by nitrate and should be avoided.

Organic Matter

(32) The amount of organic matter in the top layer of a soil influences its physical, chemical and biological properties. In particular it affects structural stability, ease of cultivation, water holding capacity and nutrient availability to plants. It also influences the behaviour of inorganic and organic contaminants. Changes in management can result in increases or decreases of organic matter.

(33) A major objective should be to maintain the organic matter in a cultivated soil so that its ability to support plant growth is not impaired. Organic contents will fall under arable farming particularly if the amount of plant residue returned to the soil is low. It may be depleted by erosion, by topsoil removal which removes the organic rich layer or by deep ploughing which dilutes the topsoil with subsoil low in organic materials.

(34) In the absence of bulky organic manures such as farmyard manure a low soil organic matter content in cultivated land can usually only be increased on a field scale by a change of cropping. If previously cultivated land is sown to grass for a number of years, the soil organic matter may be increased. To maintain this higher level, a rotation including grass may be necessary.

(35) An increased return of crop residues or application of bulky organic manures to land will result in a gradual increase in organic matter content if carried out for several years. Following the ban on burning, the incorporation of straw is expected to have only a small effect upon organic matter content.

(36) Any significant increase in organic matter will increase the amount of nitrogen made available from the soil reserves for crop growth. Unless fertiliser rates are reduced or other management practices introduced leaching of nitrate is likely to increase (see Code of Good Agricultural Practice for the Protection of Water).

SECTION 3

PHYSICAL DEGRADATION

(37) Irreversible processes of soil physical damage are defined as physical degradation. This Section of the Code describes ways in which this can be minimised or avoided by appropriate techniques.

Soil Compaction

(38) Undisturbed soils develop a soil structure which allows root growth and natural infiltration and drainage of water. The use of agricultural or other machinery when the soil is too wet can seriously compact soil and restrict root growth. This reduces water movement and subsequently restricts crop production. The choice of machinery and timing of operations should always take into account the condition of the soil. Large agricultural machinery is not necessarily a greater risk because faster work rates commonly enable operations to be completed under more favourable soil moisture conditions. The use of low ground pressure tyres can be of major benefit.

(39) The choice of crops in a particular situation should always take into account the ability to cultivate the land when required without causing compaction.

(40) In England and Wales, soil compaction is not a widespread problem and can usually be alleviated by subsequent management of the land, such as by ploughing or by sub-soiling. However if structural damage is severe and is linked with low organic matter contents, deep cultivation followed by several years in grass may be required to regenerate the soil. If damage is caused during soil restoration activities, severe compaction of the subsoil may occur which can be very difficult if not impossible to correct (See Section 5).

Topsoil Removal

(41) The formation of fertile, humus rich topsoil is a natural process which takes thousands of years. The loss of this topsoil either by direct action or indirectly as a result of management practices should be minimised. The removal or loss of topsoil reduces the productivity of the land by reducing available water and nutrients, and by leaving soil which is more liable to suffer from structural damage. Shallow compact soils are less able to absorb rainfall and the risk of water erosion may be increased.

(42) The stripping or removal of topsoil for sale is an offence under the Agricultural Land (Removal of Surface Soil) Act 1953 if planning permission is required but is not obtained. If the soil is not required as part of a development project it should be moved elsewhere for beneficial use.

(43) The removal of grass turf from agricultural land removes the surface layer of soil together with its accumulated organic matter and plant nutrients. Although modern turfing techniques only remove a shallow layer of soil, repeated cutting will reduce the productivity of the land and should be avoided.

Soil Erosion

(44) Apart from the damage caused to agricultural crops, erosion may cause contamination of surface waters by silt and by the nutrients in the eroded soil. Erosion events may also cause inconvenience to the public eg by deposition on roads. Repeated erosion events result in a gradual loss of topsoil.

Erosion by Wind

(45) In the United Kingdom significant wind erosion is normally confined to bare sandy and peaty soils in exposed situations, especially between March and June. Arable soils are commonly bare and dry during this period. The highest risk areas are in parts of the East Midlands, Yorkshire and East Anglia.

(46) Where the farming system and soil type together result in a risk of erosion, control measures should be used. Wind erosion may be controlled by reducing wind speed at ground level, by stabilising the soil surface and/or by the trapping of soil particles which are already moving. Individual methods for control are described in subsequent paragraphs.

(47) Rows of trees or hedgerows may be grown to trap airborne particles and to provide shelter for soil and for crops grown in their lee. Shelters should allow for 30-50% of the wind to pass through. Effective protection diminishes with distance and does not extend more than 20 times the height of the shelter. The benefit is dependent on the actual direction of any damaging winds.

(48) Crops such as winter rye, winter barley or mustard can be grown as nurse crops to provide protection for both soil and spring sown crops. Nurse crops may be killed either before the spring crop is drilled or with an appropriate herbicide during the early life of the crop. This method is effective for peaty and irrigated sandy soils.

(49) On peaty soils, mechanised straw planting in rows may be used to provide shelter for very early sown vegetable crops.

(50) Increasing the clay content of peats and sands, known as marling, may provide a long-term solution to wind erosion. Applications of 300-1000t/ha of suitable marling material are necessary for successful stabilisation. To be successful, the clay content of sandy topsoils should be

raised to 8-10%. This technique is unlikely to be viable unless suitable material is available close-by. The marl should be left on the soil surface long enough for the lumps to breakdown by frost action before being thoroughly cultivated in. After marling, the benefit can be lost if the soil is ploughed too deeply.

(51) Mulches applied to the surface of seedbeds on sandy soils at 5-15 t/ha after drilling are an effective annual control measure. Organic manures, sugar beet factory lime and sewage sludge are suitable materials for mulches. The use of sewage sludge must comply with the Regulations (see Paragraph 11) to ensure no damaging accumulation of heavy metals occurs in the soil. Other wastes must comply with the appropriate Regulations (paragraphs 8-9). If the mulch is disturbed by cultivations, the benefit is lost.

(52) Synthetic stabilisers such as PVA (polyvinylacetate emulsions) or PAM (polyacrylamides) sprayed onto the soil surface of sands after drilling can provide temporary protection for high value crops. This method is unsuitable on peat soils. Waste cellulose from paper production may be available locally and be suitable for surface stabilisation.

(53) Careful choice of cultivation practices can provide effective erosion control for sandlands. An erosion resistant surface can be formed by ploughing provided there is enough silt and clay in the topsoil. The land should be ploughed and pressed in one operation prior to sowing and the crop drilled at right angles to the direction of pressing without any other seed-bed cultivation. Unworked stubbles also provide an erosion resistant surface into which a spring crop may be drilled directly. To ensure satisfactory crop growth, any soil compaction should be removed by under-loosening where necessary.

Erosion by Water

(54) Soil loss by water erosion occurs from all sloping arable and ley/arable land. Severe erosion is uncommon in the UK but moderate erosion events can occur on sands and loams. The significance of losing soil from land overlying hard rock at shallow depth is much greater than where the underlying material is already weathered. Rooting depth and hence the quantity of soil water available for crops is reduced.

Occurrence of water erosion in England and Wales has increased due to the increase in area of arable cropping, widespread use of tramlines for spraying crops, the need for fine winter cereal seed-beds and the removal of strategically placed hedgerows.

(55) Water erosion may occur when rainfall intensity exceeds the infiltration rate of water into the soil surface. Appropriate management can substantially reduce the risk of this occurring. Such planning should investigate the management of the whole farm, pinpointing situations where the risk of run-off is substantial and concentrating control measures in these areas. Run-off from farm roads and tracks and from concreted areas should be minimised with drains, ditches and soak-aways.

(56) Drainage water should be controlled by maintaining land drains, pipe outlets and ditches. Where water erosion is a frequent or serious problem it may be necessary to introduce permanent grass strips as buffer areas, plant hedges or construct new interception ditches in order to restrict run-off or direct it away from areas prone to erosion.

(57) Stable topsoils should be encouraged by the application of animal manures where these are available or, in appropriate circumstances, by the introduction of grass/arable rotations. Unnecessarily deep or numerous cultivations and working of the land when it is too wet should be avoided. Compaction reduces the infiltration of water into the soil which can lead to ponding and run-off. It should be corrected before the next crop is sown.

(58) Early establishment of winter crops to ensure surface stability is crucial where erosion risk is high. In such situations winter cereals should be drilled early and without gaps for tramlines. Paths for spraying should be established after crop emergence. If tramlines are left at drilling in such situations they should not be wheeled until the spring.

(59) Cultivating and planting crops in fields "on the contour" is a practice recommended for control of erosion in many parts of the world. For mechanised agriculture it is only effective for combinable crops grown in gently sloping fields with simple slope patterns. Many fields in England and Wales have such complex slope patterns that it is not practical to follow the contours accurately. In these fields attempts at cross slope cultivations often leads to channelling of run-off water which can cause severe erosion. On steeper slopes, the risk of accidents from using machinery across fields is high and for row crops such as potatoes and sugar-beet, harvesters only work effectively up and down slope.

(60) Protection to bare ground can be provided by ensuring that some chopped cereal straw is left at the surface during cultivations. This can be achieved by using tines or discs in place of ploughing. Rough seedbeds are more stable than fine tilths and avoiding rolling after autumn drilling, particularly when soils are wet, will help maintain water infiltration rate.

(61) Cover crops such as rye, mustard or grass sown in late summer/early autumn and killed off before drilling in spring, give good control of both water and wind erosion and at the same time may reduce nitrate leaching.

(62) Land which is ridged to grow potatoes is particularly susceptible to water erosion. Use of soil walls to bridge furrows across the slope (tied ridges), and small pits (dikes) along furrow bottoms are helpful measures that encourage infiltration, reduce run-off and so prevent erosion. Such techniques are particularly valuable for irrigated crops. Irrigation water should always be applied in such a way as to avoid erosion. Excessive application rate and droplet size should be avoided.

(63) Land subject to severe and repetitive water erosion which cannot be controlled by changes in husbandry or annual cropping should be put down to permanent grass or woodland.

(64) When establishing any woodland or forestry areas precautions should be taken to avoid soil erosion. Vegetation cover should be maintained where possible and compaction by planting equipment avoided, particularly on slopes, shallow soils and in upland peaty areas. (See Forests and Water Guidelines, Forestry Commission).

Deep Cultivation and Mixing of Soil

(65) Dilution of topsoil with subsoil brought to the surface can reduce fertility and cause physical degradation.

(66) Silty and fine sandy topsoils with a low organic matter content should not be ploughed deeper than 30 cm wherever they are underlain by subsoil with a lower organic matter content. If they are, the stability of the topsoil will be further reduced. Crop establishment may be affected or wind and water erosion may be increased.

(67) Deep ploughing of shallow soils overlying parent materials such as chalk should be avoided. Failure to do so will dilute available plant nutrients, result in coarser seed-beds and slow down soil warming in spring. Rooting depth should be increased by subsoiling rather than by ploughing.

(68) Many heavy textured, poorly drained, grassland soils only develop a stable structure in the top few centimetres. Ploughing such soils can dilute organic matter, destroy natural soil drainage and so increase the risk of damage by machinery and animals. Ease and flexibility of management can be adversely affected for many years. If reseeding such swards is essential, surface seeding or shallow cultivation techniques should be employed.

(69) Soil disturbance should be minimised when trees are removed from land during the grubbing of orchards, the harvesting of standard nursery stock trees, or the clearing or harvesting of farm woodlands.

Loss of Lowland Peat

(70) England and Wales have small but important areas of peat soils in lowland areas such as the East Anglian Fens, Somerset Levels and Lancashire Mosses. When drained and fertilised they form very productive soils capable of producing good yields of root crops and vegetables. However effective drainage requires lowering of the water-table. This allows not only shrinkage through drying out of the peat but together with repeated cultivation also stimulates oxidation which leads to a reduction in the depth of peat. Several metres of peat have already been lost by these processes in parts of East Anglia. To maintain the peat, the water-table should be kept close to the surface and the site left in permanent pasture.

(71) The processes of peat wastage can only be slowed down or prevented by the full or partial reinstatement of natural conditions. These will drastically reduce the value of such soils for crop production. Compulsory set-aside for one-year periods will have little effect on the rate of wastage if water tables remain controlled at low levels for surrounding fields. Areas of lowland peat bog with natural vegetation in England and Wales have become increasingly uncommon and many such habitats are protected as Sites of Special Scientific Interest (SSSIs).

SECTION 4

CONTAMINATION

(72) This section describes the risks associated with the chemical contamination of soils and the measures necessary to avoid this happening. Man's activities may contaminate soil, either directly through the application of materials such as industrial wastes, sewage sludge or contaminated irrigation water, or indirectly by atmospheric deposition such as lead from car exhausts. Such activities usually result in a slow accumulation of contaminants over many years. The long time scale involved may mask their significance.

(73) Soil may also become contaminated by natural processes such as deposition of eroded materials which contain potentially harmful chemicals. Flooding of land by water from waste tips or mining sites can be a direct source of contamination. In such cases short- and long-term management practices may be required to protect the productivity of the soil and the safety of livestock and of humans eating crops grown there.

(74) Land may already have been contaminated by natural processes or by man's activities. Where soils have high concentrations of metals over large areas, realistic remedial measures will be prohibitively expensive. However crop growth may be improved or metal uptake reduced by appropriate management practices such as liming to raise soil pH. For smaller areas removal of contaminated soil or covering with a "clean" material may be feasible. You should take professional advice on the best way of dealing with individual problems.

(75) Contaminants can be considered under two headings:-

- Inorganic materials - such as zinc, copper, lead and arsenic which once present tend to remain in soil indefinitely, though their chemical or physical state may change with time.
- Organic materials - usually man-made chemicals such as pesticides or industrial solvents which are broken down to a greater or lesser extent by microorganisms in the soil. In some cases the result of the breakdown can be derivatives which are themselves contaminants. Even though the materials or their derivatives are broken down, repeated applications may maintain a high concentration in the soil.

(76) Inorganic and some organic contaminants may also occur naturally in soils. Therefore contamination must be assessed taking into account the background concentrations. Where these are low the deposition or addition of trace elements, such as zinc and copper, which are essential for the growth of plants and animals, may enhance the fertility of a soil.

(77) The risk associated with a particular contaminant in soil should be assessed by considering the effects on the following:-

- basic soil processes
- plant growth
- human and animal health
- water quality

(78) To protect the long-term productivity of soil it is necessary to recognise the many potential sources of contamination, to assess their significance and then to take the necessary steps to prevent, limit or ameliorate their effects.

(79) Whenever potential contaminants in waste materials are to be applied to land the competent authority must be notified. Whenever contamination is suspected, professional advice should be sought, based upon analysis of the soil and of the waste materials. A guide to acceptable concentrations and management techniques to reduce adverse effects are given in the following sections. However any figures given should not be interpreted as values to which it is safe to raise soil concentrations. Soils should be protected from all unnecessary contamination.

Legal Restrictions

(80) As explained in Section 1 legislation exists to control the application of sewage sludge and waste materials to land and sets limits with regard to the concentration of certain contaminants in soil. The legislation does not prevent any particular soil from being used for agricultural production but does set out precautions which must be taken following applications of sewage sludge to agricultural land. There are statutory limits for lead and arsenic in foodstuffs, and in order to comply with these care is necessary when food is produced on soils with naturally high contents. The UK standards for organic farming (UKROFS 1991) include limits on the content of some heavy metals in soils and in manures applied to soils, used to produce organic foods.

(81) Under the Food and Environment Protection Act 1985 there are also statutory controls on the advertisement, sale, supply, storage and use of pesticides and statutory maximum residue levels (MRLs) for pesticides in foodstuffs. The MRLs reflect maximum residues likely to arise from approved use of pesticides. Limits have also been set to reflect background levels for some persistent compounds which are

no longer in use such as DDT, dieldrin and aldrin. Controls on contamination of food by other chemicals such as dioxins may be applied.

Inorganic Contaminants

(82) Although soils may be affected by a wide range of contaminants, in practice problems usually arise from a relatively small number of elements. Elements which can cause the death of plants or reduced yields if present in high concentrations include zinc, copper, nickel, cadmium and arsenic. Elements which are harmful to animals or man if ingested in sufficient quantities include lead, arsenic, cadmium, mercury, copper, fluorine, selenium and molybdenum.

Ingestion by Livestock

For most elements, the risk of poisoning of livestock grazing grass grown on a contaminated soil depends almost entirely on the amount of soil ingested and the toxic element concentration in that soil. This is because the concentration of the element in the soil will be very much more than in the herbage. This concentration factor overrides the fact that the herbage may more readily release the element inside the animal. The amount of soil contamination on herbage will vary with the type of sward, its density, the time of year, weather conditions, stocking density and management. In a dense sward, where a surface mat has developed, soil contamination of the diet may be less than 3% by weight of dry matter. In reseeded pastures, with an incomplete vegetation cover, soil contamination is commonly as high as 10% or more. Care should be taken that hay and silage is not contaminated with soil during harvesting. This means ensuring that cutting equipment and pick-up reels are not set so low that they touch the soil.

The risk to livestock depends on:

- Levels of soil and herbage contamination
- Variations in dietary intake over the year.
- Differences in element availability to stock.
- Type, species, age and health of stock.
- Length of exposure.
- Provision of supplementary feedstuffs

There is a limited amount of reliable information on livestock tolerance to metals and other contaminants. Therefore only a broad classification for soil concentrations can be attempted based on herbage concentration and animal intake, assuming a specified proportion of soil is ingested in the diet.

(83) Metals can occur in soils in a range of physical and chemical forms. The form determines their toxicity to plants and animals. The absolute content in a soil may be determined by physical-chemical procedures although accuracy at low concentrations may be poor. Traditional soil analysis is undertaken by a range of chemical extractants. Most commonly, strong mineral acids such as aqua regia (a mixture of nitric and hydrochloric acids) are used. The values quoted in this Code are consistent with such strong acid digestion which are commonly referred to as "total" concentrations. They relate to a sampling depth of 25 cm unless otherwise stated.

Zinc

(84) Zinc is an essential trace element for crop growth but in high concentrations it is toxic to plants. It is readily taken up by plant roots and translocated into leaves. In excess it restricts photosynthesis and affects the metabolism of elements such as iron resulting in a severe yellowing of the whole plant. These symptoms usually show long before there is any risk to animal health. It affects animals through interaction with other elements, such as copper.

Concentrations of zinc from materials such as minespoil may be tolerated by certain plants up to 2000 mg/kg of soil depending on soil pH and other factors. Zinc accumulations derived from industrial wastes, atmospheric deposition or sewage sludge are more available to plants and sensitive species may be affected above about 300 mg/kg of total zinc in the soil.

Zinc itself is unlikely to affect animals until dietary intake exceeds 300-1000 mg/kg dry matter, depending on animal species, chemical and physical form of the zinc and the balance of other nutrients in the diet. Herbage concentrations greater than about 220 mg/kg dry matter are likely to have a significant effect on copper metabolism in grazing livestock.

Copper

(85) Copper is not so readily taken up into the leaves of plants as zinc but may accumulate in the roots. Soil pH has little effect on plant uptake of copper except in very acid conditions (less than pH 4.5) when it appears to be mobilised and is taken up by acid-tolerant species. Although copper is an essential plant nutrient, it can be toxic to plants at high concentrations. If material containing copper is applied to a growing crop, copper can be directly adsorbed to the foliage.

The effect of a given concentration of copper on livestock depends upon species and on dietary interactions with other elements. At a soil pH of 6.0 or above a total soil concentration of copper from geological materials up to 500 mg/kg would allow the growth of productive grasses but not necessarily other species. Above this level, the concentration of copper in soil and herbage is likely to exceed the toxic threshold for sheep and lambs. Dietary copper levels greater than 10 mg/kg diet dry matter are toxic for the most susceptible breeds of sheep. If grazing contaminated land is unavoidable, it should only be grazed in high copper situations for short periods so that soil ingestion is kept to a minimum.

Lead

(86) Lead in soils above pH 6.0 is rarely toxic to plants but the ingestion of soil-contaminated herbage can be a hazard to livestock at all pHs. Monogastric animals, (pigs, poultry and horses) are considerably more susceptible to lead poisoning than are ruminants such as cattle and sheep. Precautions should be considered where soils have a natural total lead content greater than about 300 mg/kg. In alkaline soils ($pH > 7.0$) lead is insoluble but following ingestion of contaminated soil by grazing animals, it may be absorbed by them.

Lead contamination of crops is unlikely to exceed statutory limits in food. When vegetables are grown and sold from a soil containing more than about 300 mg/kg of total lead, care should be taken to minimise soil contamination so as to comply with these limits.

Cadmium

(87) Cadmium is often found in association with geological deposits of lead and zinc. It is taken up by plant roots and translocated into the leaves and seeds. This effect is greater at low pH and varies with plant species. Cadmium ingested by grazing animals accumulates in offal, especially kidney and liver. The guideline level for cadmium in soil is set to limit human intake. Plants are unaffected at this level.

The availability of cadmium to plants varies with its physical and chemical form. Cadmium in mine spoil is generally less available to plants than cadmium in sources such as sewage sludge and some industrial wastes. The soil limit of 3 mg/kg of total cadmium must be met where sewage sludge is applied and should be met elsewhere. Where land is contaminated by spoil from lead mines the commonly associated high concentrations of zinc and/or lead will have a much greater direct effect on plants and/or animals than will the cadmium.

Arsenic

(88) Arsenic is absorbed and accumulated by plant roots and in high concentrations it may kill them. However, it does not move readily to leaves or stems. A soil concentration of 250 mg/kg of total arsenic is not likely to cause any ill effects upon plants and animals. Concentrations in excess of 500 mg/kg can kill plants and cause animals to consume

sufficient arsenic to accumulate in offal and, in extreme cases, to result in poisoning. Soil contamination on fresh produce offered for sale should be kept to a minimum if soil concentrations exceed 50 mg/kg so as to minimise the risk of exceeding statutory limits in food.

Fluorine

(89) Fluorine in soils is normally present as insoluble calcium fluoride and in this form is not readily taken up by plant roots. If soil high in fluorine or grass contaminated by fluorine is ingested over a sufficiently long period of time, livestock can suffer from a deterioration of the teeth and bones known as fluorosis.

A total soil concentration of fluorine, from whatever source, of 500 mg/kg could result in herbage which exceeds the safe threshold of 30 mg/kg dry matter in the diet.

Nickel

(90) Nickel is toxic to plants and in order to protect against damage to crops or animals, a limit of 75 mg/kg of total nickel exists for soil at pH 6-7 receiving sewage sludge. Other limits apply for different soil pHs. (See Appendix 1).

Chromium

(91) Concern has been expressed about the addition of chromium to soil because of the toxicity to plants and animals of the chromate (VI) ion. However, the conditions found in organic waste materials or in soil are such that it will in almost all cases exist only as the relatively inert chromic (III) ion.

Chromium (III) is unlikely to be toxic to plants in any but extremely acid soils. Land to which sewage sludge is applied must contain less than 400 mg/kg of total chromium.

Mercury

(92) The amount of mercury in soil which will kill plants is far above that encountered under natural conditions or even from any likely form of contamination. Plant roots serve as an effective barrier to uptake. However mercury is among the most toxic elements to man and many higher animals. Soil concentrations should be limited to less than 1 mg/kg of total mercury.

Selenium

(93) The addition of selenium to soils can readily result in concentrations in excess of 2 mg/kg in plants which is the safe limit for animal diets. Toxicity of livestock does not normally occur until selenium intake exceeds 5 mg/kg in the diet. To minimise risk, the soil concentration of total selenium should be kept below 3 mg/kg.

Soils naturally high in selenium are rare in England and Wales but pose a risk to grazing livestock where they occur.

Molybdenum

(94) Molybdenum is an element where precautions need to be taken to limit uptake by livestock. High molybdenum in herbage (> 5 mg/kg) reduces the availability of copper to livestock and may induce copper deficiency. Waste materials should not be applied to agricultural land so as to raise soil concentrations above 4 mg/kg of total molybdenum. However where natural soil levels exceed this value and livestock are receiving copper therapy further applications of sewage sludge containing molybdenum may be permitted under the Code of Practice for Agricultural Use of Sewage Sludge. Any additions should only be made under veterinary supervision. Some soils naturally contain in excess of 100 mg/kg of total molybdenum.

Sodium and Chloride

(95) Plants growing on sea-flooded land may be damaged by being deprived of oxygen or by physical disturbance of soil around their roots. Saline water leaves residues of sodium and chloride in the soil. High chloride levels inhibit plant growth and decrease the ability of the root system to take up water from the soil. High levels of sodium in the soil will lead to dispersion of clay particles and result in soil structural problems, especially in non-calcareous soils (See Paragraphs 126-136 on Sea Water Flooding).

Organic Contaminants

(96) Sewage sludge, town refuse, and other domestic and industrial wastes may contain organic chemicals which pose a threat to the environment.. A large number of compounds could be involved and it is not practicable to identify or to monitor all of them during land application. Before any wastes are applied to land, analysis should therefore be undertaken for any that are likely to be present in significant amounts. In the absence of such knowledge, indicator compounds should be determined to assess the overall concentration of contaminants. Specialist advice should be taken.

(97) The majority of organic compounds are lost from soil by volatilisation or broken down in the soil but at widely differing rates. The breakdown products may also be harmful. The precautions taken when wastes or pesticides are applied to soil must ensure that there is no risk to water supplies or the food chain. For longer-term soil protection, applications should not have a deleterious effect upon soil fertility through effects on soil organisms. The amount or frequency of application should not cause accumulation in the soil. This is particularly important for compounds such as polychlorinated biphenyls (PCBs) and the more persistent pesticides which break down slowly in soils.

(98) The following compounds are given as an indication of those commonly encountered. Amongst the group of benzene derivatives are dichlorobenzene used in toilet disinfectants, and alkyl benzenes used in detergents. Polychlorinated bi-phenyls (PCBs) were used as insulating agents whilst polynuclear aromatic hydrocarbons (PAHs) are products of combustion which occur at moderate levels in industrial wastes. Some dioxins and furans are known to be carcinogenic at very low concentrations and they must receive close attention when their presence is suspected. Many pesticides are potential contaminants especially if the recommendations given on the label are not followed.

(99) Contamination of soil by mineral oils reduces plant growth by blocking soil pores and creating anaerobic conditions. Some oils are also directly toxic to plants (See Paragraphs 137-143 on Oil Spillage).

Industrial Contamination

(100) An appreciation of the potential contamination of sites resulting from previous use of land for industrial purposes including mining for metals is of importance where such sites are being returned to agriculture or to other uses where plants are to be grown. Advice and guidance on contaminated land is given in a series of guidance notes published by the Department of The Environment on behalf of the Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL). Recommended threshold trigger concentrations for organic and inorganic contaminants are given according to the proposed use. For gardens and allotments action is suggested at lower concentrations than for recreational, amenity or forestry areas where the risk of human exposure to the contaminants is much less.

(101) It is unlikely that industrial sites, other than old mining areas, will be returned to agriculture. However, if this is planned the ICRCL garden and allotment thresholds should apply, except in the case of grazing on old mining areas where separate guidelines have been prepared. (ICRCL 70/90).

(102) Simple management practices such as liming to reduce the availability of metals or cultivation to mix the soil or cause accelerated decomposition should be considered to make contaminated sites safe for their intended use. Specialist remedial treatment techniques may be needed. This will be of particular importance if the site poses a threat of contaminating ground or surface waters by leaching or erosion. It may be possible to make the site acceptable by capping with uncontaminated material. For more seriously contaminated sites a range of treatment processes have been developed. These are specialist operations which must be selected according to the particular requirement.

(103) Appropriate consultants and contractors should be employed. The processes for treatment are variously based on physical, chemical and biological treatments which either remove, detoxify or immobilise the contaminants. The costs of such operations are far in excess of the value of land for agricultural purposes.

Atmospheric Deposition

(104) Atmospheric deposition of metal contaminants onto soil may arise from natural sources such as wind erosion or volcanic activity. These are supplemented by human activities which may cause a large deposition in the vicinity of a source such as an industrial complex. They may be dispersed more thinly over a wide area from activities such as coal burning. Controls over industrial emissions to the atmosphere have increased in recent years such that damaging long-term deposition is less likely in future. In the UK natural deposition of contaminants is of little significance. However vigilance is required near industrial sites to protect the soil, crops and livestock from accidental emissions. Radioactive fall-out from a nuclear accident is dealt with by specific Government action according to the particular circumstances and general advice is not given in this Code.

Sewage Sludge

(105) Sludge application to agricultural land is controlled by the Sludge (Use in Agriculture) Regulations 1989 which implement EC Council Directive 86/278 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture. The risks have been evaluated and controls formalised but they are kept under review and may need to be amended in the light of results from current research. Many other materials contain one or more of the potential contaminants present in sewage sludge and may pose similar problems.

(106) The Sludge Regulations and supporting DoE Code of Practice for Agricultural Use of Sewage Sludge (HMSO 1989) cover the hazards arising from organic matter, plant nutrients, metal and other inorganic contaminants, organic micro-pollutants and microorganisms affecting the health of livestock or humans. Of these, organic micro-pollutants have been discussed (see paragraphs 95-98). Risks to human or animal health from disease organisms are outside the scope of this Code. Responsibility for compliance with the legal requirements on concentrations of metal contaminants rests with the producer of sludge, but it is an offence to cause or knowingly permit sludge to be used on agricultural land when this does not comply with the requirements of the Regulations. Enforcement is the responsibility of Her Majesty's Inspectorate of Pollution (HMIP). Farmers should ensure that they are aware of these requirements as explained in the DoE Code.

(107) Recycling the carbon and plant nutrients that are in sewage sludge to agricultural land is a positive environmental objective. However sludge contains a number of heavy metals which accumulate in soils after repeated application. These metals are the result of industrial discharges and of inputs from domestic sources. They remain in soils virtually forever and any adverse effects may increase as the associated carbon is broken down by natural soil processes. These effects may include restrictions on crop growth, increased intake of metals by animals and man via food, and reductions in soil microbial activity.

(108) In recognition of these problems the EC members agreed the Directive which amongst other things required Member States to introduce metal limits in soils. Those adopted by the UK are at or near the maximum allowed by the Directive.

The application of zinc, copper, nickel, cadmium, lead, mercury and chromium are subject to legal restrictions upon both the amount applied and the ultimate concentration in the soil (Appendix 1) in samples taken to a depth of 25 cm, or the depth of top-soil if less. In addition, the UK Code of Practice gives non-statutory limits for the application of molybdenum, selenium, arsenic and fluoride. It is considered that any other inorganic contaminants present in sludge will not pose a hazard, provided the limits are observed for these major contaminants. These limits have been set to take into account toxicity to plants and animals, effects on the food chain and on soil processes. As such they are subject to review in the light of new information which may become available.

(109) The Code also provides recommendations for the maximum concentration of contaminants in soils under grass to a depth of 7.5 cm. These are intended to limit the risk to grazing stock by soil ingestion and to lessen the damage to plants whose roots may proliferate in this surface layer. If these concentrations are exceeded at 7.5 cm, the soil should be cultivated to disperse the metals before further applications are made.

(110) The Regulations and Code give different metal limits according to the acidity (pH) of the soil. It is important that pH is maintained at the appropriate level both during and after sludge applications. Most metals become more available in acid soils and adverse effects will then increase. Selenium and molybdenum increase in availability to plants at high pH. When sludge is applied up to the allowed limits there will be a need to maintain pH for an indefinite period. Sludge should not be applied to agricultural land with a pH below 5.0.

(111) The Regulations and Code referred to in paragraph 110 relate only to agricultural land. They do not apply to forestry, land reclamation, amenity or service areas. For forestry a separate Code of Practice has been issued which

recommends that the concentration limits in Appendix 1 relating to pH 5.0-5.5 should apply. This allows for the acidic nature of many forest soils. For other land use situations the metal concentration limits in Appendix 1 for the appropriate pH should apply.

Other Industrial and Domestic Wastes

(112) The disposal of wastes subject to the Control of Pollution Act 1974 are regulated by the Collection and Disposal of Waste Regulations 1988. Such wastes can only be applied to land without a licence if the material is applied "for the purpose of fertilising or otherwise beneficially conditioning that land". There is no definition of a fertiliser in this context but the elements that may be considered as fertilisers in agriculture in England and Wales were identified in paragraph 26 as those essential for plant growth. At least part of the content of these elements should be or become available for plant uptake within 3 years.

Apart from consideration of whether a waste is a fertiliser, the following factors also need to be considered. The amount applied should not exceed that required by the crop or rotation of crops. Applications must not pollute water-courses or have other detrimental environmental effects.

(113) Beneficially conditioning the land should be regarded as a long-term physical improvement. The temporary increase in soil moisture through the water in dilute wastes would not be considered as beneficial conditioning.

Even if a waste meets the criteria of fertilising or conditioning beneficially, it must not be applied to land if it contains unacceptable quantities of potential contaminants.

(114) Contaminants applied to soil may subsequently affect water quality if they are leached or eroded into ground or surface waters. Application of wastes containing contaminants should always be undertaken so that the risk to water quality is minimised by avoiding run-off, and in the longer-term by avoiding losses to the aquatic environment. (See Code of Good Agricultural Practice for the Protection of Water).

(115) When wastes are known, or suspected, to contain elements not specifically covered in this Code all relevant information should be assessed to decide if land application is desirable and if so at what rate.

Animal Manures

(116) The principal contaminants in animal manures are copper and zinc but EC legislation has reduced the permitted concentration in feedstuffs, and hence the quantities in manures are now reduced. On fields with a history of repeated applications, the content of these metals in pig and poultry manures and slurries should be checked by analysis together with the concentrations in the soil. Samples should be taken to a depth of 15 cm for arable and 7.5 cm for grassland. If the soil values approach the limits in Appendix 1, professional advice should be sought concerning future manure disposal on this land.

(117) Animal manures contain variable but relatively high quantities of the major plant nutrients. When manures are applied according to the Code of Good Agricultural Practice for the Protection of Water the accumulation of metal contaminants will be limited. The Water Code includes a maximum guide figure for total nitrogen in organic manures of 250 kg/ha per year which should be used, with due consideration for possible phosphorous and potassium accumulation. Lower amounts may be appropriate in sensitive catchments such as Nitrate Sensitive Areas.

Inorganic Fertilisers

(118) The amount of inorganic fertilisers used should not be more than required by the crop. Detailed fertiliser recommendations are given in MAFF/ADAS Reference Book 209 "Fertiliser Recommendations for Agricultural and Horticultural Crops". Potentially harmful accumulations of nutrients should be avoided, as should the over-application of liming materials.

(119) Raw materials used as inorganic fertilisers such as rock phosphate may be applied in a relatively unprocessed form or may undergo chemical and physical processing. In the first case, any contaminating materials will find their way into the soil but may or may not be readily available to crop plants. Processing to increase the availability of the plant nutrients may also increase the availability of any contaminants, or it may remove some or all of them into a waste fraction.

(120) All fertilisers should be monitored by manufacturers to establish the concentration of any contaminants and the quantity applied to the soil under normal usage. Of particular concern will be cadmium and, to a lesser extent, uranium in phosphate fertiliser.

Pesticides

(121) Pesticides in England and Wales are subject to controls made under Part III of the Food and Environment Protection Act 1985 (FEPA). The Control of Pesticides Regulations 1986 (COPR), provides legal controls over the advertisement, sale, supply, storage and use of pesticides in England, Scotland and Wales. The MAFF/HSC statutory Code of Practice for the Safe Use of Pesticides on Farms and Holdings (1990) provides guidance on all aspects of pesticide use including the disposal of wastes and washings, containers, packaging and other contaminated materials. Practical guidelines to avoid pesticide pollution of water are given in the Code of Good Agricultural Practice for the Protection of Water. Guidance on avoiding pollution of water is directly relevant to avoiding pollution of soil. Both these Codes should be read in the context of protection of soil.

(122) Most pesticides are organic compounds which are broken down in the soil by physical and chemical processes and by microorganisms. Such compounds must by law only be applied at a rate and in a manner consistent with their authorisation. This is granted on the basis that when correctly used the chemical will have no discernible long-term effect upon the environment. The regular use of certain soil acting herbicides may leave residues which take several years to degrade after applications cease.

(123) Several pesticides have inorganic elements in the active ingredients. Repeated use of compounds containing lead, arsenic and copper raises the levels of these elements in some soils, particularly those used for intensive horticultural production. Even where such persistent materials are still cleared for use they are no longer widely applied. In the rare cases where repeated applications may be made, soils should be analysed and concentrations of the specific metal compared with those in Appendix 1 to determine if further use is advisable.

Dredging Materials

(124) Materials dredged from settlement ponds or natural waters such as ponds, lakes, rivers, etc should not be spread on agricultural land until any contaminating elements have been identified, professional advice sought and a satisfactory programme of land application and subsequent management established. Identification should be confirmed by analysis of the material according to local enquiries on potential contaminants. The source of the contaminants, eg geological or industrial wastes, will determine their likely affect on crops or livestock. Appropriate action limits will vary accordingly.

Remedial Treatment

(125) All practical steps should be taken to avoid contamination of soil. When accidental or natural emissions occur which cause contamination, action programmes should be put in place to limit the damage and where possible treat the soil. Two situations where relatively straightforward management practices can overcome problems are sea water flooding and oil spillage.

Sea Water Flooding

(126) When sea flooding occurs, it is important that the water on the soil surface is dispersed as rapidly as possible back to the sea or river, in order to minimise residues of sodium and chloride in the soil. When possible surface channels should be dug by hand to aid the removal of water from low-lying areas. Over large areas the use of low ground pressure equipment might be more practical. Sea water may also be dispersed by pumping. The sooner surplus water is removed, the sooner the recovery process can start.

(127) In freely-draining soils, average winter rainfall in England and Wales is adequate to remove most of the residual chloride in one winter. If flooding occurs in late winter or spring, this process will not be complete until the end of the next winter. This process may be hastened if the soil is left uncropped for the first summer following flooding.

(128) On less well-drained soils, the leaching process may take 2 or 3 winters to remove all the excess chloride. If the soil is very poorly drained with little or no water movement through the soil, the profile will remain contaminated. This is a particular problem if the soil is very dry at the time of flooding, allowing deep penetration of salt water. More usually the soil is already wet when flooded and in this condition the salt water does not penetrate to a great depth.

(129) Soils with pipe drainage will recover naturally as long as the system is fully working. The number of winters needed to leach the excess chloride will depend on the soil structure and the effectiveness of the leaching process.

(130) On soils which contain above 1200 mg/l of water soluble chloride in the top 20 cm, tolerant plant species such as barley or rye-grass should be grown initially rather than more sensitive species such as legumes or brassicas.

(131) As water moves through the soil the initially high soil sodium level will be reduced by leaching. Unless the sodium is immediately replaced by calcium or magnesium, the clay particles will disperse and the soil will become

very difficult to cultivate. Soils with a high silt and/or clay content are most at risk of structural deterioration. Peaty and coarse sandy soils are less prone to damage.

(132) To maintain satisfactory structure, the soil must contain a ready supply of soluble calcium or magnesium. This may come from a high natural calcium carbonate content or from added gypsum. The latter is calcium sulphate which is more soluble in water than calcium carbonate. Gypsum applied at 5 t/ha as soon as possible after the soil has dried out is recommended for cultivated soils which are susceptible to structural deterioration and have been flooded with sea water. This is likely to be beneficial even if the soil already contains some calcium carbonate.

(133) Gypsum is most effective if left on the soil surface and not ploughed down. Further application may be necessary on non-calcareous clay soils which have been flooded for a lengthy period.

(134) Soils in grassland only justify gypsum treatment if they are both weakly structured and non-calcareous. Peaty and coarse sandy soils do not generally justify treatment.

(135) To ensure rapid recovery from flooding damage, it is particularly important that cultivations are not carried out under wet conditions. Avoid spring sown crops until the soil structure is fully restored.

(136) Adequate fertiliser should be applied since any nutrient shortage will aggravate the problem. If drought conditions develop irrigation with non-saline water should be carried out where possible.

Oil Spillage

(137) When an oil spillage of any volume occurs the primary concern is to minimise the fire hazard and to prevent the oil entering sewers, watercourses or groundwater. The National Rivers Authority should be informed of any risks to surface or groundwaters. The next step is physically to remove as much of the spillage as possible and dispose of it safely so minimising the amount left to be degraded by soil microorganisms or to be lost by volatilisation. Off-site disposal of the contaminated soil should be to a licensed site.

(138) If light oil such as diesel or gas oil penetrates the topsoil but is held up by an impermeable subsoil or the water table, it may be possible to dig sumps, allow the oil to drain into them and then pump them out. It is important that the sump does not penetrate the impermeable layer. Do not apply water or detergents to try and flush the oil from the soil and do not try to burn oil on the soil surface.

(139) Crude and heavy oils will remain largely on the soil surface. This should be scraped up and removed from the site, taking as little topsoil as practicable. This may be made easier if the oil is allowed to dry first. It will also reduce the risk of machinery damaging the soil during the clean-up operation.

(140) The next stage in restoring the soil is to ensure that the conditions for microbiological breakdown of the remaining oil are as favourable as possible. All soils contain microorganisms capable of degrading oils. They need adequate temperature, water, oxygen and nutrients. If the soil is in a suitable state, surface cultivation will improve oxygen supply and the mixing of soil and oil will increase the rate of breakdown.

(141) For heavily contaminated soils, inorganic nitrogen and phosphorus fertiliser should be applied before cultivating to ensure an adequate nutrient supply for the microorganisms. Do not add organic manures to oil contaminated land as these increase the demand of soil organisms for oxygen and plants could be adversely affected.

(142) The time for complete soil recovery depends on the type and quantity of oil contamination. Spillages of light oil will generally affect the soil for 1-2 years. After this plant growth is likely to be unaffected. By contrast spillages of crude and heavy oil may take 5 years or longer before the soil is capable of growing a wide range of plant species again.

(143) Commercial companies offer services for the clean-up of soil contaminated with oil and other organic contaminants, using microbiological and other appropriate techniques. Advice should be sought from an appropriate consultant as to the correct course of action for the particular contaminant which has to be treated.

SECTION 5

RESTORATION OF DISTURBED SOILS

(144) This section of the Code gives advice on measures to minimise the impact of soil disturbance by minerals extraction, landfill, pipeline laying and other civil engineering works on farmland. It provides information on the nature of safeguards that need to be adopted to ensure that the long-term quality of the soil is protected. The primary responsibility for applying most of the measures and safeguards described will rest with developers, contractors, mineral and landfill operators and planners.

It is not the intention of this Code to provide comprehensive guidance on detailed planning or operational practices. It does however, provide farmers with an outline of operational standards and requirements that are likely to be placed upon operators. It also advises farmers on measures they may take themselves to ensure that appropriate controls are applied and the agricultural aftercare managements practices which are necessary to ensure that disturbed soils are restored to satisfactory standards for farming.

(145) The overall aim is to ensure that:-

- soil damage is minimised;
- soil is restored to at least its original quality as quickly as possible: the MAFF Agricultural Land Classification (ALC) grading is normally used;
- restored soil is not damaged by inappropriate farming operations.

Legislation

Minerals extraction and landfilling

(146) Virtually all development to extract minerals and landfill waste requires planning permission under the Town and Country Planning Act 1990 (as amended by the Planning and Compensation Act 1991). When an application is made, the landowner and tenant of land involved will be notified. Enquiries on the details of the application should be made and any views should be put to the Planning Authority within 21 days.

When consent is granted it is normally subject to planning conditions which control site working, restoration and aftercare management. These conditions are applied to ensure that land is reinstated to an appropriate standard. Detailed guidance on these aspects is provided by Minerals Planning Guidance Note 7 "The reclamation of Minerals Workings" (DOE, 1989) and will also be in future 'good practice guidelines' to be published by DoE.

Landfill sites taking controlled wastes require management licences, currently under the Control of Pollution Act 1974, to be replaced from April 1993 by the Environmental Protection Act 1990.

(147) It is the responsibility of the site operator to ensure that the planning conditions are complied with. Enforcement is the responsibility of the minerals planning authority. However, in the event of the authority being unable to take enforcement action against an operator eg due to bankruptcy, action may be taken against the landowner.

(148) Landowners should consider securing additional safeguards by negotiating legally binding agreements with the prospective developer. These may seek to ensure that proposed site working restoration/aftercare practices and standards satisfy the landowner. They may also provide financial penalties and security against default by the site operator and/or other third parties.

Pipelines

(149) Legislation is contained in several Acts which are often specific both to the material conveyed (oil, gas, water) and the status of the promoting organisation (private, public, agency). The main statutes are the Pipelines Act 1962, Gas Acts 1965 and 1972, Water Act 1989, Water Industry Act 1991, Water Resources Act 1991 and the Town and Country Planning Act 1990.

(150) Detailed operational requirements are given in BS 8010 - British Standard Code of practice for pipelines. The Department of the Environment has also prepared a model code of practice which sets out the responsibilities of water and sewerage pipeline undertakers in accordance with Sections 159 and 160 of the Water Resources Act 1991.

(151) Codes of practice based on this model have been prepared by individual water companies and specifically approved by DoE. Both the BS and Water Resources Act codes give detailed recommendations for soil stripping, storage and reinstatement. The BS code is not a statutory document and it is important to ensure that you comply with all legal obligations which may mean more than just complying with the Code.

(152) Engineering works are carried out for an Authority who has normally used compulsory powers to purchase land or acquire licences for the temporary use of land to carry out essential works. As a consequence the landowner usually has little control over soil movements. However, the landowner and occupier may be approached by contractors with offers of private agreements for site offices and borrow pits or for the disposal of surplus soil materials.

Planning the Work

(153) For all sites good planning requires attention to detail. No shortcuts should be attempted. Once damage to soil is caused it may be incapable of being remedied at reasonable cost and in some cases may be so severe that agricultural afteruse becomes uneconomic.

(154) All operations must be planned and carried out without incursion by personnel or equipment onto surrounding farmland. This is important, not only to minimise soil disturbance but also to prevent the spreading of soil borne plant and animal diseases. Further guidance is provided in the booklet "Preventing the Spread of Plant and Animal Diseases - A Practical Guide" (MAFF 1991).

(155) Before operations commence, the developer should commission a survey of the site to provide an inventory of soil materials including topsoil and subsoil depths. It is important that this data is accurately prepared as it will provide the basis of the operator's proposals for soil handling in the site working and restoration scheme to be submitted for approval by the minerals planning authority.

(156) The scheme may include:-

- intended soil stripping depths;
- ways of keeping different soils apart;
- soil handling methods;
- the location and height of soil mounds;
- proposals for reinstating soils including the location, depth and composition of reinstated soil profiles;
- installation of appropriate pipe drainage and methods for restoring disrupted land drains;
- commitments for undertaking necessary remedial works eg ripping or de-stoning operations.

(157) On many sites there may also be a risk of off site flooding which can cause considerable soil damage. Where this is the case, site proposals should also include plans to deal with any disruption of water courses and underdrainage systems and with any increased surface run-off.

(158) Before approving a scheme for minerals extraction, the minerals planning authority should discuss the proposals with all interested parties, including the landowner and MAFF where restoration to agriculture is involved. MAFF will seek to ensure that the soil depths, stripping and storage proposals are adequate to ensure the protection of soil quality before these requirements are written into planning conditions.

(159) In addition to any planning conditions and private agreements (see paragraph 148) a method statement should be prepared by the operator to translate the working arrangements approved by the minerals planning authority

into practical instructions for use by those involved in the day-to-day working of the site. This is important as soil reinstatement techniques for agricultural use often differ from those for preparing the ground for construction purposes.

Site working

(160) The quality of the restoration depends very much on the standard of work of individuals on the site. The operator must ensure operations proceed in accordance with the working scheme and method statement. If the landowner believes that a serious breach of these conditions is occurring, this should be brought to the attention of the operator. If the matter cannot be satisfactorily resolved, the landowner should bring it to the attention of the Minerals Planning Authority if there is a breach of planning conditions. Private legal action may be appropriate if the private agreement with the operator is breached. However, actual conditions and operational requirements on the site rarely correspond exactly to those anticipated. Adjustments, therefore, often need to be made during operations to achieve the best results. For example, changing weather conditions may affect soil handling. The following provides a general indication of what you might expect during site working operations.

Soil stripping

(161) Topsoils and subsoils should be stripped to agreed depths. Agricultural topsoil is the dark surface layer which varies in depth between sites from 20-40cm. Subsoil is the underlying usually lighter coloured soil material. Soils on minerals sites should be stripped to a minimum depth of 1.2 metres below the original ground surface unless rock or other materials make this impracticable.

(162) Soils should only be stripped and transported when they are sufficiently dry. Care will also be taken to ensure that no unnecessary trafficking of machinery occurs across unstripped soils or storage mounds.

Soil Storage

(163) If restoration is already taking place elsewhere on the site, soils should not be stored but re-instated immediately. However, immediate replacement is not always practicable and some storage is generally unavoidable. Where this is the case, topsoil and subsoil will always be stored separately. They should not be moved from the site unless specifically agreed in the scheme of working and planning conditions.

(164) Before subsoil storage mounds are constructed the operator should remove the topsoil from the area where the mound is to be located. Both topsoil and subsoil should be removed from areas used for storage of overburden. The height of storage mounds will be determined by operational and planning requirements.

(165) Where soils are to be stored for more than 6 months, mounds should normally be seeded with grass to minimise erosion and weed infestation. Any excess weed growth should be controlled.

Soil-Reinstatement

(166) Soils should be reinstated upon appropriately contoured and prepared ground as specified in the restoration scheme. They should also be replaced in correct sequence; subsoils first, then topsoils to the depths previously agreed. Care must be taken to avoid soil losses or contamination with overburden (non-soil material eg excavated clays and shales), stones or other foreign objects. After settlement, soil depths should normally match those of the original undisturbed profile and also, wherever practicable, aim to provide 1.2 metres of cover for crop growth and to allow the installation of underdrains.

(167) Adequate soil depth is particularly important on landfill sites. Otherwise damage may be caused to leachate and gas control systems by subsequent agricultural operations. If it is not possible to provide sufficient cover above these systems for farming operations such as subsoiling and/or under-drainage, then the feasibility of restoration to agricultural use must be reconsidered.

(168) For pipelines the reinstated soil depth should be at least 0.9 metres above the top of the installed pipe. It is not unusual to have surplus soil following reinstatement. Topsoil should normally be used on site. Any disposal off site will have been agreed between the landowner and the operator. Particular attention must be given to the interception and reinstatement of existing underdrainage systems and/or the need to install additional underdrainage as part of the reinstatement process.

(169) Periodicic site meetings should be held between all interested parties to inspect the work and assess the need for remedial treatments such as leveling, ripping to remove compaction and stone removal.

Agricultural Aftercare

(170) Soil that has been reinstated will take several years to rehabilitate. Restored soils invariably suffer some structural damage and require a period of specialised agricultural aftercare management before they are suitable for normal agricultural use. The purpose of the aftercare period should be primarily to re-establish good structure in restored soils rather than immediately seeking to maximise productivity.

(171) On restored minerals sites, agricultural husbandry is normally controlled by planning conditions for five years from soil replacement. Information on the legislation and guidance relating to conditions for aftercare and the preparation of aftercare schemes by those responsible for managing aftercare is given in paragraph 146.

(172) Whilst responsibility for aftercare rests with the operator, there are many options for the management of the land during the aftercare period. Operators may choose to manage the land themselves. Alternatively, agricultural contractors may be employed or licences and short term letting used, share farming arrangements etc. It is important that aftercare management is carried out promptly and effectively and that due emphasis is given to the need to rehabilitate land for the longer term and not for short term profit.

(173) A farmer or landowner may seek, or be offered by the operator, the opportunity to assume responsibility for aftercare. Before taking up this option, the farmer should carefully consider the financial cost of meeting the aftercare obligations laid down by the minerals planning authority as any private agreement between the farmer and the operator will be legally binding and the farmer will then be liable for any penalties and costs for non compliance with the aftercare scheme.

(174) Although statutory aftercare obligations apply to most sites as described in paragraph 146, there may be some sites which are not subject to this legislation. However, even on sites where statutory obligations do not apply, but land is to be restored to agriculture, farmers should still take account of the following guidance to ensure the land recovers properly.

Cropping

(175) It is not possible to make standard recommendations for aftercare cropping as much will depend upon site, soil and climatic conditions. However, as a general rule, crop cover should be established as soon as practicable after restoration, to protect sites from erosion by water. Early crop establishment is also beneficial as it permits roots to penetrate cracks and fissures. These roots will assist the soil to dry out during the spring and summer thereby improving ground conditions for other farming operations and remedial treatments.

(176) When selecting aftercare crops, it needs to be borne in mind that the structural properties of restored soils are usually less favourable for crop growth or farming operations than those of their unworked counterparts. Nutrient reserves are likely to be lower and soil aeration and drainage poorer. Crops which are tolerant of such conditions should be chosen.

(177) Grass is the preferred option for aftercare cropping especially for clay soils in high rainfall areas. However difficulties can be experienced in utilising this crop in some arable areas and winter cereals may be an appropriate alternative except on heavy soils or in high rainfall areas. Unless grazing management can be closely controlled so that livestock are removed when the soil is wet, grass should be cut rather than grazed, if practicable. Winter barley should not be grown on acid soils.

(178) Spring cereals should normally be avoided except on well drained land in dry areas due to the increased risks of damage to soil structure by spring cultivation and the problem of establishing a satisfactory crop in wet years. Oilseed rape and other combine harvested crops are not recommended unless soil structure conditions are good and an effective under-drainage system has been installed.

(179) Root crops such as potatoes and sugar beet should not be grown since late harvesting will normally prevent remedial subsoiling and may result in bare land over the winter. There is also the risk of serious soil structural damage when harvesting in wet years.

Cultivations

(180) Because of the sensitivity of restored soils (see paragraphs 170 and 176) particular care is required in timing cultivation. Disturbed soils should therefore be given a high priority when planning farm work as there are normally fewer suitable days available for cultivations on restored land.

Lime and Fertiliser

(181) Soil pH and nutrient levels, especially phosphorus, can fall during long-term storage of soil. Since rapid establishment of crop cover is important, lime or nutrient deficiencies should be corrected by appropriate applications of lime and fertilisers. To ensure that appropriate rates are applied, soil analyses should be carried out immediately after soil replacement and repeated at intervals of 2 years throughout the aftercare period.

(182) During the aftercare period, sufficient fertiliser should be applied to encourage vigorous root growth to assist soil structural recovery and to build up nutrient reserves to levels suitable for normal agricultural cropping at the end of the aftercare period. Unnecessarily high single application rates should be avoided to minimise losses by leaching or surface run-off which could cause water pollution.

Drainage

(183) Establishment of satisfactory soil drainage is an essential feature of aftercare husbandry. Poor drainage should be corrected since it can adversely affect crop growth, reduce work days, shorten the grazing period and generally increase soil susceptibility to structural damage. Effective remedial subsoiling operations cannot be undertaken unless an effective drainage system is in place and the soil is dry.

(184) Underdrainage will normally be required where artificial drainage existed before soil disturbance. It will also be required where soils have been damaged during working. The system should be designed to control the watertable at least 500mm below the surface for arable crops and 300mm for grass within a 48 hour rainfall event. On clay and compacted soils it will normally be necessary to carry out mole drainage and/or subsoiling to achieve this. Specialist advice on drainage design should be taken.

(185) On most sites underdrains should be installed as soon as practicable after soil reinstatement. This will maximise opportunities for carrying our essential remedial treatments and minimise the risk of soil structural deterioration under wet conditions.

Subsoiling

(186) Frequent subsoiling is usually necessary to improve soil permeability and root penetration. It should be carried out in late summer or early autumn when subsoiling is dry, using a single or multi-bladed winged tine machine. When subsoiling is undertaken in grassland, care should be taken to minimise damage to grass sward.

(187) Agricultural subsoiling is generally only effective to depths of about 350mm where compaction is serious. However, deeper benefits can be achieved by progressively increasing subsoiling depth over a number of years. Soil profile inspections should be carried out to assess the need for subsoiling and the most appropriate depth for working. Specialist advice should normally be taken. Further inspection should also be carried out immediately before starting work to confirm that the subsoil is dry enough and during work to ensure that the cultivation is effective.

Grazing Management

(188) To minimise surface compaction and poaching, grassland should be grazed by sheep and young cattle. Alternatively the land should be cut for hay or silage and the aftermath lightly grazed. Livestock should be removed from the land over winter and in wet conditions and the farm machinery should be kept off the land whenever the soil is wet.

Monitoring

(189) The progress of soil structural development should be carefully monitored throughout the aftercare period. For restored minerals sites annual site review meetings may need to be held between the site operators and minerals planning authorities and other interested parties to agree the detailed aftercare programme for the forthcoming year and the need, if any, for remedial treatments. A final meeting may also be required at the end of the aftercare period to ensure that all planning conditions have been fulfilled.

Long-Term management

(190) Once the land is released from aftercare it remains important to pay attention to the need for maintaining good soil management practices. Intensification of agricultural use should not be rushed and decisions to grow more demanding crops or increase stocking rates should be made on the basis of proven experience gained from farming the restored land. A cautious approach is usually best in the long term. Otherwise, serious damage may occur and this can be slow and costly to rectify.

Appendix 1 Maximum permissible concentrations of potentially toxic elements (PTEs) in soil after application of sewage sludge to agricultural land and maximum annual rates of addition.

PTE	Maximum permissible concentrations of PTE in soil (mg/kg dry solids)				Maximum permissible average annual rate of PTE addition over a 10 year period (kg/ha)(2)
	pH(1) 5.0-5.5	pH(1) 5.5-6.0	pH 6.0-7.0	pH(3) >7.0	
Zinc	200	250	300	450	15
Copper	80	100	135	200	7.5
Nickel	50	60	75	110	3
	For pH 5.0 and above				
Cadmium	3				0.15
Lead	300				15
Mercury	1				0.1
Chromium	400 (Provisional)				15 (Provisional)
* Molybdenum(4)	4				0.2
* Selenium	3				0.15
* Arsenic	50				0.7
* Fluoride	500				20

* These parameters are not subject to the provisions of Directive 86/278/EEC

(1) For soils in the pH ranges 5.0-5.5 and 5.5-6.0 the permitted concentrations for lead, zinc, copper, nickel and cadmium are provisional and will be reviewed when current research into their effects on certain crops and livestock is completed.

(2) The annual rate of application of PTE to any site shall be determined by averaging over the 10 year period ending with the year of calculation.

(3) The increased permissible PTE concentrations in soil of pH greater than 7.0 apply only to soils containing more than 5% calcium carbonate.

(4) The accepted safe concentration of molybdenum in agricultural soils is 4 mg/kg. However there are some areas in UK where, because of local geology, the natural concentration of this element in the soil exceeds this level. In such cases there may be no additional problems as a result of applying sludge, but this should not be done except in accordance with expert advice. This advice will take account of existing soil molybdenum levels and current arrangements to provide copper supplements to livestock.

REFERENCES

Appendix 2

1. Legislation

Control of Pollution Act 1974, Chapter 40, HMSO (ISBN 0 10 544074 4)

Environmental Protection Act 1990, Chapter 43, HMSO (ISBN 0 10 544390 5)

Town and Country Planning Act 1947, Chapter 51, HMSO

Town and Country Planning Act 1990, Chapter 8, HMSO (ISBN 0 10 540890 5)

Planning and Compensation Act 1991, Chapter 34, HMSO (ISBN 0 10 543491 4)

Radioactive Substances Act 1960, Chapter 34, HMSO (ISBN 0 10 850228 7)

Agricultural Land (Removal of Surface Soil) Act 1953, Chapter 10, HMSO

Food and Environment Protection Act 1985, Chapter 48, HMSO (ISBN 0 10 544885 0)

Pipelines Act 1962, Chapter 58, HMSO (ISBN 0 10 850098 5)

Gas Act 1965, Chapter 36, HMSO - OUT OF PRINT

Gas Act 1972, Chapter 60, HMSO (ISBN 0 10 546072 9) OUT OF PRINT

Gas Act 1980, Chapter 37, HMSO (ISBN 0 10 543780 8)

Gas Act 1986, Chapter 44, HMSO (ISBN 0 10 544486 0)

Water Act 1989, Chapter 15, HMSO (ISBN 0 10 541589 8)

Water Industry Act 1991, Chapter 56, HMSO (ISBN 0 10 545691 8)

Water Resources Act 1991, Chapter 57, HMSO (ISBN 0 10 545791 4)

EC Council Directive 86/278/EEC on the Protection of the Environment and in Particular of the Soil, when Sewage Sludge is used in agriculture. HMSO

Sludge (Use in Agriculture) Regulations 1989 S.I 1989 No. 1263, HMSO (ISBN 0 11 097263 5) as amended by the Sludge (Use in Agriculture) Regulations 1990 S.I 1990 No. 880, HMSO (ISBN 0 11 003880 0)

Collection and Disposal of Waste Regulations 1988, S.I 1988 No. 819, HMSO (ISBN 0 11 086819 6)

Control of Pollution (Special Waste) Regulations 1980, S.I 1980 No. 1709, HMSO (ISBN 0 11 007990 6) as amended by Control of Pollution (Special Waste) (Amendment) Regulations 1988, S.I 1988 No. 1790, HMSO (ISBN 0 11 087790X)

Control of Pesticides Regulations 1986 S.I 1986 No. 1510, HMSO (ISBN 0 11 067510X)

(You can get these from HMSO Bookshops or HMSO Publications Centre (071 873 0011))

2. Codes of Practice

Code of Good Agricultural Practice for the Protection of Water. MAFF 1991. PB 0587.

Code of Good Agricultural Practice for the Protection of Air. MAFF 1992. PB 0618

(You can get these free of charge from MAFF Publications, London SE99 7TP or telephone 071 694 8862.)

Code of Practice for Agricultural Use of Sewage Sludge. Department of Environment 1989. (£3.15) (ISBN 0 11 752256 2)

Code of Practice for the Safe Use of Pesticides on Farms and Holdings. MAFF/Health and Safety Executive 1990. (£5.00) (ISBN 0 11 242892 4)

Guidance on Good Practice to be published by Department of Environment

(You can get these from HMSO Bookshops or HMSO Publications Centre (071 873 0011))

3. Other Publications.

MAFF Reference Book 209 Fertiliser Recommendations for Agricultural and Horticultural Crops. HMSO 1988. (£7.50) ISBN 0 11 242813 4.

(You can get this from HMSO Bookshops or HMSO Publications Centre (071 873 0011))

Preventing the Spreading of Plant and Animal Diseases - A Practical Guide. MAFF 1991. PB 0486

(You can get this free of charge from MAFF Publications, London SE99 7TP or telephone 081 694 8862.)

Forests and Water Guidelines. Forestry Commission 1988.

(You can get this from Forestry Commission, 231 Corstorphine Road, Edinburgh EH12 7AT.)

UKROFS Standards for Organic Farming. UK Registry of Organic Food Standards 1991. Reference OB4 revised 1992.

(You can get this from UK Register of Organic Food Standards, Food from Britain, 301 - 344 Market Towers, New Covent Gardens Market, London SW8 5NQ.)

Interdepartmental Committee on the Redevelopment of Contaminated Land (ICRCL) - Guidance on the Assessment and Redevelopment of Land. (£2.25) Department of Environment 2nd Edition 1987.

(You can get this from Department of Environment Publications Sales Unit, Government Buildings, Block 3, Spur 2, Room 1, Lime Grove, Eastcote, Middlesex HA4 8SE (081 429 5170))

Minerals Planning Guidance Note No.7 - The Reclamation of Minerals Workings. Department of Environment/ Welsh Office 1989. (£5.30) HMSO (ISBN 0 11 752234 1)

(You can get this from HMSO Bookshops or HMSO Publications Centre (071 873 0011))